

# **Recommended Practices for Machinery Installation and Installation Design**

**Manufacturing, Distribution and Marketing Department**

**API RECOMMENDED PRACTICE 686**

**PIP REIE 686**

**FIRST EDITION, APRIL 1996**



**Process Industry Practices**



**American  
Petroleum  
Institute**

## SPECIAL NOTES

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication date as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Authoring Department [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API *standard*. Questions concerning the interpretation of the content of this standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

All rights reserved. No part of this work may be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, N.W., Washington, DC 20005.

## **FOREWORD**

API publications may be used by anyone desiring to do so. Every effort has been made by the institute to assure the accuracy and reliability of the data contained in them; however, the institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.



## CONTENTS

	Page
CHAPTER 1—INTRODUCTION .....	1-1
CHAPTER 2—RIGGING AND LIFTING .....	2-1
CHAPTER 3—JOBSITE RECEIVING AND PROTECTION .....	3-1
CHAPTER 4—FOUNDATIONS .....	4-1
CHAPTER 5—MOUNTING PLATE GROUTING .....	5-1
CHAPTER 6—PIPING .....	6-1
CHAPTER 7—SHAFT ALIGNMENT .....	7-1
CHAPTER 8—LUBRICATION SYSTEMS .....	8-1
CHAPTER 9—COMMISSIONING .....	9-1



# **Recommended Practices for Machinery Installation and Installation Design**

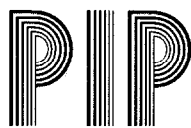
## **Chapter 1—Introduction**

**Manufacturing, Distribution and Marketing Department**

API RECOMMENDED PRACTICE 686

PIP REIE 686

FIRST EDITION, APRIL 1996



**Process Industry Practices**



**American  
Petroleum  
Institute**



# CONTENTS

	Page
CHAPTER 1—INTRODUCTION	
1.1 Scope .....	1-1
1.2 Alternative Installation .....	1-1
1.3 Conflicting Requirements .....	1-1
1.4 Definitions .....	1-1



# Recommended Practices for Machinery Installation and Installation Design

## CHAPTER 1—INTRODUCTION

### 1.1 Scope

#### 1.1.1 PURPOSE

These recommended practices (RP) are intended to provide recommended procedures, practices, and checklists for the installation and precommissioning of new and reapplied machinery for petroleum, chemical, and gas industry services facilities. In general, these recommended practices are intended to supplement vendor instructions and the instructions provided by the original equipment manufacturer (OEM) should be carefully followed with regard to equipment installation and checkout.

Most major topics of these recommended practices are subdivided into sections of "Installation Design" and "Installation" with the intent being that each section can be removed and used as needed by the appropriate design or installation personnel.

#### 1.1.2 EQUIPMENT CLASSIFICATION

These recommended practices are intended to address those installation and construction procedures associated with all machinery. Additional "special purpose" requirements are covered at the end of each section as required.

### 1.2 Alternative Installation

The installation contractor or design contractor may offer alternative methods of equipment installation as mutually agreed upon by the user and equipment manufacturer.

### 1.3 Conflicting Requirements

Any conflicts between these recommended practices and/or the manufacturers' recommended procedures shall be referred to the owner's designated machinery representative for resolution before proceeding.

### 1.4 Definitions

**1.4.1 alignment:** The process of reducing the misalignment of two adjacent shafts connected by a coupling so that the center of rotation for each shaft is as near collinear as practical during normal operation.

*Note:* Most misalignment is combination misalignment. It can be resolved into a parallel offset at a given point along the fixed machine centerline and angular misalignment in both the horizontal and vertical planes. The offset is dependent on the location along the fixed machine centerline where it is measured, normally the center of the coupling spacer.

**1.4.2 ambient offset:** The practice of misaligning two shaft centerlines at ambient conditions to account for the es-

timated relative changes in shaft centerlines from ambient conditions to operating conditions.

**1.4.3 angular misalignment:** The angle between the shaft centerline of two adjacent shafts. This angle is normally reported in slope of millimeters of change per decimeter of linear distance (mils per inch) (1 mil = 0.001 inch).

**1.4.4 blowdown system:** A closed system connected to a machine used to depressure and decontaminate the machine preparatory to maintenance activities; also known as a *maintenance dropout system*.

**1.4.5 bolt bound:** Where any hold-down bolt is not free in the bolt hole, so that the ability to move the moveable element in a machinery train horizontally or axially is constrained.

**1.4.6 breakout spool:** A short, flanged length of pipe immediately connected to the machinery piping flanges. Lengths vary with the size of the pipe but range from 15 centimeters (6 inches) to 1 meter (3 feet). The purposes of this spool are to facilitate machinery installation, allow piping modification to reduce pipe strain, isolate the machinery, facilitate commissioning activities such as flushing or blowing lines, and allow removal of temporary inlet strainers; also known as a *dropout spool*.

**1.4.7 cementitious grout:** A type of grout material that is portland cement based.

**1.4.8 combination misalignment:** When the centerlines of two adjacent shafts are neither parallel nor intersect. This misalignment is normally described in both angular and offset terms.

**1.4.9 condensing service:** A gas stream that contains a vapor component that may condense to a liquid during startup, operation, or shutting-down of a compressor or blower. This may include pure vapors such as refrigerants as well as hydrocarbon gas streams. When condensate is present in the gas stream, the term *wet gas* may be used. *Wet gas* may also be used as a synonym to *condensing service*.

**1.4.10 dead-leg:** A length of piping with no flow.

**1.4.11 designated machinery representative:** The person or organization designated by the ultimate owner of the equipment to speak on his behalf with regard to machinery installation decisions, inspection requirements, and so forth. This representative may be an employee of the owner, a third party inspection company, or an engineering contractor as delegated by the owner.

**1.4.12 drop point:** A vertical section of oil mist distribution piping that is usually smaller in diameter than the

main oil mist header. This piping rises out of a tee in the main oil mist header, turns horizontally, and extends downward to the machinery being lubricated.

**1.4.13 elastomeric coupling:** A coupling that obtains its flexibility from the flexing of an elastomeric element.

**1.4.14 engineering designer:** The person or organization charged with the project responsibility of supplying installation drawings and procedures for installing machinery in a user facility after machinery has been delivered. In general, but not always, the engineering designer specifies machinery in the user facility.

**1.4.15 epoxy grout:** A type of grout material that consists of a resin base that is mixed with a curing agent (hardener) and usually an aggregate filler.

**1.4.16 equipment user:** The person or organization charged with operation of the rotating machinery. In general, but not always, the equipment user owns and maintains the rotating machinery after the project is complete.

**1.4.17 equipment installer:** The person or organization charged with providing engineering services and labor required to install machinery in a user facility after machinery has been delivered. In general, but not always, the installer is the project construction contractor.

**1.4.18 equipment train:** Two or more rotating equipment machinery elements consisting of at least one driver and one driven element joined together by a coupling.

**1.4.19 final alignment:** The aligning of two adjacent machinery shafts after the measurement of piping-imposed strains on the machinery are verified as being within the specified tolerances.

**1.4.20 flexible-element coupling:** A type of rotating machinery coupling that describes both disk and diaphragm couplings. A flexible-element coupling obtains its flexibility from the flexing of thin disks or diaphragm elements.

**1.4.21 gear coupling:** A type of rotating machinery coupling that obtains its flexibility by relative rocking and sliding motion between mating, profiled gear teeth.

**1.4.22 general purpose equipment trains:** Those trains that have all general purpose elements in the train. They are usually spared, relatively small in size (power), or in noncritical service. They are intended for applications where process conditions will not exceed 48 bar gauge (700 pounds per square inch gauge) pressure or 205°C (400°F) temperature (excluding steam turbines), or both, and where speed will not exceed 5000 revolutions per minute (RPM).

Note: General purpose equipment trains have all elements that are either manufacturer's standard or are covered by standards such as the following: ANSI/ASME B.73 horizontal pumps, small API Standard 610 pumps, fans, API Standard 611 steam turbines, API Standard 672 air compressors, API Standard 677 general purpose gears, API Standard 674 reciprocating pumps,

API Standard 676 rotary positive displacement pumps, API Standard 680 reciprocating air compressors, and NEMA frame motors.

**1.4.23 general purpose:** Refers to an application that is usually spared or is in noncritical service.

**1.4.24 grout:** An epoxy or cementitious material used to provide a uniform foundation support and load transfer link for the installation of rotating machinery. This material is typically placed between a piece of equipment's concrete foundation and its mounting plate.

**1.4.25 grout pin:** A metallic pin or dowel used to tie an epoxy grout pour to its concrete foundation to prevent delamination (or edge lifting) due to differential thermal expansion between the grout and the concrete.

**1.4.26 head box:** A device used to funnel grout into a baseplate grout fill-hole so as to provide a static head to aid in filling all baseplate cavities with grout.

**1.4.27 isolation block valve:** A valve used to isolate a process machine preparatory to maintenance. Also known as a *block valve* or *isolation valve*.

**1.4.28 mechanical piping analysis:** An analysis of the piping connected to a machine to determine the stresses and deflections of the piping resulting from dynamic loadings such as pulsating flow. Determination of the type, location, and orientation of piping supports and piping guides results from this analysis.

**1.4.29 minimum flow bypass:** (See *recycle line*.)

**1.4.30 mounting plate:** A device used to attach equipment to concrete foundations; includes both baseplates and soleplates.

**1.4.31 nonslam check valve:** A mechanically or hydraulically balanced check valve that allows closure of the valve in a controlled fashion. Wafer-style center-guided spring-loaded split-disc check valves or tilting-disc check valves are representative designs.

**1.4.32 NPS:** Nominal pipe size.

**1.4.33 oil mist application fittings:** Long path orifices that cause the small oil droplet size in the header ("dry mist") to be converted to larger size oil droplets ("wet mist") to lubricate the bearings. Oil mist application fittings are also known as *reclassifiers*.

**1.4.34 oil mist distributor block:** A small rectangular block that has four or more holes drilled and tapped in opposite faces. *Drop points* terminate in distributor blocks. An oil mist distributor block may also be described as an *oil mist manifold block*.

**1.4.35 oil mist console:** A system consisting of the oil mist generator, oil supply system, air filtering system, oil mist header outlet, and necessary controls and instrumentation. Air and oil enter the console to produce oil mist.